Nanocomposites and nanomaterials

High energy density electrode materials with inorganic coating for lithium-ion batteries

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In an effort to enhance energy and power outputs, lithium-ion battery (LIB) electrode materials advancement is increasingly focused on nanosizing, or more commonly, mesoporous crystallites comprised of partially agglomerated nanocrystals. The challenge is to enhance LIB chemistry while reducing electrochemical activity on the active particles surface. Inorganic acid-resistant and ceramic-like coatings are the solution.

The candidate list of inorganic coatings includes carbon, Al_2O_3, SiO_2, TiO_2, ZnO, MgO, ZrO_2, AlF_3, LaF_3, LiF, $AlPO_4$, Li_3PO_4, $Li_4Ti_5O_{12}$, etc. Although they inhibit side reactions between the electrode and the electrolyte, electrochemical parameters modified electrodes are not always sufficient for practical application, especially at elevated temperatures and high charge voltage of LIBs. One reason for this is the inhomogeneity and nonuniformness of the individual particles coating. If the coating is uniform, the electron blocking pathways leading to increased impedance.

To overcome these shortcomings, we have developed a methodology of integrating electrode material nanoparticles with conductive ceramic matrix/nanocoating SiOC&C, which is chemically inert and mechanically strong [1,2]. Such electrode materials for LIBs do not have analogues in the world. The chemical inertness of the coating guarantees protection electrode materials from the powerful influence of HF as impurity in the electrolyte and contributes to the formation of effective passivation layer comprised of polymer degradation products of organic electrolyte.

1. *Kuksenko S.P.* Silicon-Containing Anodes with Low Accumulated Irreversible Capacity for Lithium–Ion Batteries // Russ. J. Appl. Chem.-2013. -**86**, N 5. -P. 703-712.
2. *Kuksenko S.P.* Silicon-Containing Anodes with High Capacity Loading for Lithium–Ion Batteries // Russ. J. Electrochem.-2014.-**50**, N 6.-P. 537-547.